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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/902,607	07/12/2001	Yeong-Kwan Kim	249/258	1299

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EXAMINER	
THOMAS, TONIAE M	

ART UNIT	PAPER NUMBER
2822	

DATE MAILED: 11/05/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/902,607	Applicant(s) KIM ET AL.	
	Examiner Toniae M. Thomas	Art Unit 2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 August 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *16-35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *21-35* is/are allowed.

6)☒ Claim(s) *16-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 July 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

1. This action is an official response to the amendment filed on 19 August 2003. Currently, claims 16-35 are pending.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. *Claims 16, 17, and 20 are rejected under 35 U.S.C. 103(a) as being obvious over Tu et al. (US 6,177,307 B1) in view of Park et al. (US 6,326,282 B1) and Gadgil et al. (US 5,879,459 B1).*

Claims 16, 17, and 20 are unpatentable over the combination of Tu et al., Park et al., and Gadgil et al. as set forth in the Office action mailed on 21 May 2003.

The applied reference Park et al. (US 6,326,282 B1) has a common assignee and at least one common inventor with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art only under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 103(a) might be overcome by: (1) a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not an invention "by another"; (2) a showing of a date of invention for the claimed subject matter of the application which

corresponds to subject matter disclosed but not claimed in the reference, prior to the effective U.S. filing date of the reference under 37 CFR 1.131; or (3) an oath or declaration under 37 CFR 1.130 stating that the application and reference are currently owned by the same party and that the inventor named in the application is the prior inventor under 35 U.S.C. 104, together with a terminal disclaimer in accordance with 37 CFR 1.321(c). For applications filed on or after November 29, 1999, this rejection might also be overcome by showing that the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person. See MPEP § 706.02(l)(1) and § 706.02(l)(2).

Tu et al. disclose a method for fabricating a semiconductor device (see figs. 1A-1H and accompanying text). The method comprises: forming a trench 202, 204, 206, 208 in a semiconductor substrate 200 (fig. 1A), and forming a buried insulating layer filled in the trench without a void (fig. 1A and col. 2, lines 11-14).

Tu et al. do not teach the following limitations: forming a liner layer formed of a multi-layer of silicon nitride and silicon oxide on the sidewalls and bottom of the trench by atomic layer deposition (ALD), wherein the liner layer is formed without breaking vacuum; and forming an oxide layer by thermal oxidation or ALD on the sidewalls and bottom of the trench before the liner layer is formed on the sidewalls and bottom of the trench.

Park et al. disclose a method for fabricating a semiconductor device that is compatible with Tu et al (figs. 2A-2E and accompanying). The method comprises: forming a trench 110 in a semiconductor substrate 100 (fig. 2B); forming a liner layer formed of a multi-layer of silicon nitride 114 and silicon oxide 115 on the sidewalls and bottom of the trench (fig. 2D and col. 4, lines 32-52); and forming a thermal oxide layer 112 on the sidewalls and bottom of the trench before the liner layer is formed on the sidewalls and bottom of the trench (fig. 2C and col. 4, lines 25-31). The oxide layer 115 is formed to protect the nitride layer 114, which serves as a stress relief layer and an oxidation barrier layer (col. 3, lines 35-38). The thermal oxide layer is formed prior to forming the liner layer so as to remove the damage caused by etching the substrate to form the trench.

The Gadgil et al. reference is relied upon in this action because it teaches that ALD is a better thin film coating method than the conventional CVD methods (col. 1, lines 34-37; col. 2, lines 42-49; col. 3, lines 38-60). One advantage of using ALD is: it provides uniformity and excellent step coverage (col. 1, lines 34-37). ALD has the ability to maintain ultra-uniform thin deposition layers over complex topology (col. 2, lines 42-49).

Gadgil et al. also teach that forming thin film layers without breaking vacuum is an inherent property of the ALD coating method (fig. 1a and col. 3, lines 5-20).

Since Tu et al., Park et al., and Gadgil et al. are from the same field of endeavor, the purpose disclosed by Park et al. and Gadgil et al. would have been recognized in the pertinent art of Tu et al.

One having ordinary skill in the art would have been motivated to modify Tu et al., at the time the invention was made, by forming a multi-layer of silicon nitride and silicon oxide on the sidewalls and bottom of the trench using atomic layer deposition, and forming a thermal oxide layer on the sidewalls and bottom of the trench prior to forming the silicon nitride/silicon oxide multi-layer because of the following reasons: the oxide layer protects the nitride layer, which serves as a stress relief layer and an oxidation barrier layer; the thermal oxide layer removes the damage to the substrate caused by etching the substrate to form the trench; and ALD provides a silicon nitride/silicon oxide multi-layer having uniformity and excellent step coverage.

3. *Claims 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tu et al., Park et al., and Gadgil et al. as applied to claim 16 above, and further in view of Wolf et al. (Silicon Processing for the VLSI Era: Vol. 1 - Process Technology).*

Claims 18 and 19 are unpatentable over the combination of Tu et al., Park et al., Gadgil et al., and Wolf et al. as set forth in the Office action mailed on 21 May 2003.

Park et al. do not teach that the nitride layer is formed using a silicon source of silane, Si-alkoxide, Si-alkyl, Si-halide, or Si amide, and a nitrifying agent of ammonia, plasma ammonia, or plasma nitrogen; or that the silicon oxide layer is formed using a

silicon source of silane, Si-alkoxide, Si-alkyl, Si-halide, or Si amide, and an oxidizing agent of water, hydrogen peroxide, ozone, plasma O_2, N_2O, or plasma N_2O.

Wolf et al. disclose methods for forming silicon nitride and silicon oxide films. Wolf et al. teach forming silicon oxide films using silane as a silicon source and an oxidizing agent of N_2O (page 184, 4th par.), and forming silicon nitride films using silane as a silicon source and ammonia as the nitrifying agent (page 194, 1st par.).

One of ordinary skill in the art would have been motivated to modify the combination of Tu et al., Park et al., and Gadgil et al., at the time the invention was made, by forming the silicon oxide layer using silane and N_2O and forming the silicon nitride layer using silane and ammonia, as taught by Wolf et al., because: [1] a silicon oxide film that is formed by reacting silane and N_2O is less dense and has a high etch rate, and a silicon oxide film that is formed by reacting silane and ammonia has good step coverage.

Allowable Subject Matter

4. Claims 21-35 are allowable. As stated in the previous Office action, claims 32-35 are allowable because the prior art of record does not anticipate, teach or suggest the following limitations recited in claim 32: [1] forming a first bubble prevention layer of a multi-layer of silicon oxide and silicon nitride on the gate spacers and the gate stack patterns by ALD, or [2] forming a second bubble prevention layer of a multi-layer of silicon oxide and silicon nitride on the bit line spacers and the bit line stack patterns by ALD. Claims 21-31 are allowable because the prior art of record does not anticipate,

teach, or suggest the limitation of forming a first bubble prevention layer of a multi-layer of silicon oxide and silicon nitride on the gate spacers and the gate stack patterns by ALD, as recited in claim 21.

Response to Arguments

5. Applicant's arguments filed 19 August 2003 have been fully considered but they are not persuasive. The Applicant argues that: **[1]**"the Tu et al. reference does not teach or suggest forming a buried insulating layer filled in the trench without a void, as suggested by the examiner, and as recited in claim 16 of the subject application...the Tu et al. reference includes no further teaching regarding the STI regions, and completely omits any reference to a problem of void formation in a trench"; **[2]** "the Park et al. reference does not address the problem of void formation in a buried insulating layer and does not teach forming a buried insulating layer filled in a trench without a void, as recited in claim 16 of the subject application"; and **[3]** the Gadgil et al. reference "also fails to address the problem of void formation in a buried insulating layer in a trench, and does not teach or suggest forming a buried insulating layer filled in a trench without void, as recited in claim 16 of the subject application."

6. First, Applicant improperly argues against the references individually. One cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Claim 16

is rejected under 35 USC §103 as being unpatentable over the combination of Tu et al., Park et al., and Gadgil et al.

7. In response to the argument that the Tu et al. reference does not teach or suggest forming a buried insulating layer filled in the trench without a void, and completely omits any reference to a problem of void formation in a trench, it is the examiner's position that absent any evidence to the contrary, the Tu et al. patent, on its face, teaches the limitation of "forming a buried insulating layer filled in a trench 202 204 206 208 without a void" (fig. 1A and col. 2, lines 11-14). The Applicant has the burden of *proving* (emphasis added) otherwise. That is, the Applicant must provide evidence to the contrary. Furthermore, it is not necessary that the Tu et al. patent make reference to a problem of void formation in a trench.

8. In response to the argument that Park et al. does not address the problem of void formation in a buried insulating layer and does not teach forming a buried insulating layer filled in a trench without a void, the Park et al. patent is relied upon because it teaches the following limitations, as recited in claim 16: forming a liner layer formed of a multi-layer of silicon nitride 114 and silicon oxide 115 on the sidewalls and bottom of the trench (fig. 2D and col. 4, lines 32-52); and forming a thermal oxide layer 112 on the sidewalls and bottom of the trench before the liner layer is formed on the sidewalls and bottom of the trench (fig. 2C and col. 4, lines 25-31).

9. In response to the argument that Gadgil et al. fails to address the problem of void formation in a buried insulating layer in a trench, and does not teach or suggest forming

a buried insulating layer filled in a trench without void, the Gadgil et al. patent is relied upon because it teaches that ALD is a better thin film coating method than the conventional CVD methods.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Toniae M. Thomas whose telephone number is (703) 305-7646. The examiner can normally be reached on Monday through Thursday from 8:30 AM to 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (703) 308-4905. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

JMJ
27 October 2003

AMIR ZARABIAN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800